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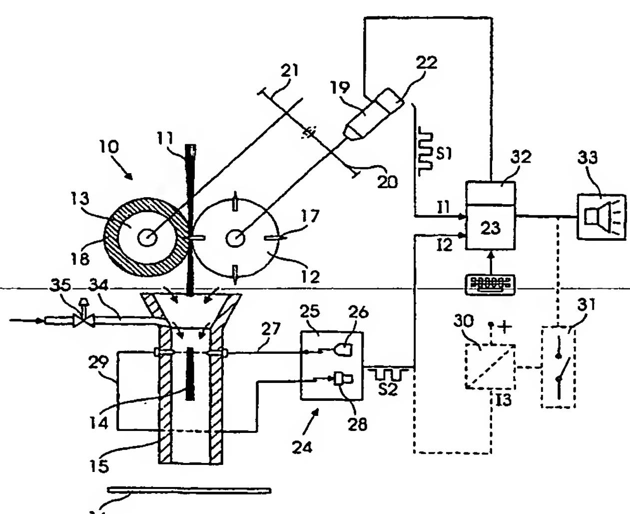

(57) Abstract: A method and apparatus for cutting fibre material (11) and for monitoring the flow of cut tufts (14); a strand (11) of fibre material is fed through rollers (12, 13) of a cutting device (10), by means of which the fibre material is cut into tufts (14) of preset length which are entrained by an air flow along an ejection conduit (15). The working conditions of the cutting device (10) and the flow of tufts (14) are monitored by comparing the real cutting frequency of the tufts (14), provided by an optical detection device (24), downstream of the cutting device (10), with a preset threshold value or theoretical cutting frequency provided by a pulse signal generator (22) operatively connected to the rollers (12, 13) of the cutting device (10).

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METHOD AND APPARATUS FOR CUTTING AND MONITORING CUT FIBRE MATERIAL

FIELD OF THE INVENTION

The present invention relates to the general field of fibre reinforced material and more precisely is directed to a method and apparatus for cutting into tufts a fibre material normally used as reinforcement material in numerous applications.

In particular the invention is directed to a method and an apparatus for cutting fibre material, by means of which it is possible to monitor continuously, in real time, the working conditions of a rotating cutting device and the flow of tufts of cut fibres which travel along a guide and ejection nozzle or conduit.

PRIOR ART

Rotating cutting devices for raw fibre materials are widely known and used in numerous areas of application, for example for the production of plastic materials reinforced with glass, carbon or synthetic fibres or with fibres of any other type, or for the production of preforms into a mould.

Cutting devices of this kind substantially comprise a cutting roller, provided with a plurality of angularly spaced apart blades, which blades extend radially and longitudinally to the same cylinder, and a backing roller, parallel and adjacent to the cutting roller to support a roving of fibre material to be cut; the back roller usually is provided with a covering in a soft material, for example in rubber, and co-operates with the cutting roller so as to

draw and cut a roving or strand of fibres into tufts or staples having a preset length which substantially depends on the angular space between the blades of the cutting roller.

After cutting, the individual tufts of fibres are trapped by a flow of air which entrain them along a guide tube or ejection nozzle so as to be mixed with a plastic material, for example with a liquid mixture of chemically reactive components suitable for forming a polyurethane material, or to be distributed in a mould or onto a substrate in the preparation of preforms.

Cutting devices of this kind are known or described, for example, in GB-A-1.360.803, GB-A-1.579.543, WO-A-95/01939 and WO-A-96/02475.

With cutting devices of this type however the problem exists of controlling the cutting conditions, for example of knowing whether the cutting blades are efficient, worn or whether some of them are broken or faulty, and of monitoring the flow conditions of the tufts of cut fibres while they are entrained by an air flow stream, to be mixed with a liquid mixture of a plastic material, ejected and/or laydown into a mould or onto an underlying substrate. Practically, for various reasons, the cutting blades become worn in time or are damaged, or the tufts of fibres become tangled and accumulate at the inlet side of the ejection conduit, clogging it before an operator becomes aware thereof in good time and can intervene.

Problem also exists of changing the cutting length of the fibres, maintaining the control of the working conditions of the cutting device and monitoring the flow of cut fibres while they are conveyed towards and along the guide and

ejection conduit.

As regards control of the working conditions of the fibre cutting device, at present no suitable solutions for this purpose are known. In actual fact with WO-A-95/01939 and WO-A-96/02475 the use of signals generators has been proposed for detecting the rotational speed of the cutting device and respectively of the feeding rollers for feeding the strand of fibres to be cut, upstream the same cutting device.

However, use of signal generators is merely proposed for controlling the length of the fibre tufts, or for changing it according to specific working needs. No control of the cutting device and no monitoring of the flow of cut fibres is therefore proposed or made possible.

In particular WO-A-95/01939 suggests to connect the cutting device to a first signal generator, and to connect the fibre feeding device to a second signal generator to detect the respective rotational speeds, modifying the cutting length of the tufts by changing the rotational speed of the fibre cutting device and/or of the fibre feed device.

Contrarily WO-A-96/02475 makes provision for forming the cutting roller with circumferential grooves which extend between adjacent cutting blades to allow free sliding of the fibre strand between two successive cuts.

At present it does not appear therefore that anyone has ever considered the problem of controlling the working conditions of a rotating cutting device for materials in fibres or the like, nor of monitoring the flow of cut fibres, nor of seeking solutions to these problems.

OBJECTS OF THE INVENTION

The general object of the present invention is therefore to provide an apparatus for cutting raw fibre material, suitable for allowing control of working conditions and monitoring of the flow of cut fibres, to avoid or detect malfunctioning.

Another object of the invention is to provide an apparatus of the kind mentioned above, comprising a cutting device of the rotary type, appropriately provided for changing the cutting length of the fibres, maintaining a constant control in real time of the working conditions and monitoring the fibre flow.

A further object of the present invention is to provide a method for controlling the working conditions and monitoring the flow of fibres in cutting apparatus of the kind mentioned above.

Yet another object of the invention is to provide a control method and apparatus for cutting fibre material, as referred above, by means of which it is possible to monitor the wear conditions of the cutting blades, and possible clogging of the ejection conduit for the fibres, and more generally the onset of causes which prevent and obstruct the regular flow of cut fibres in a nozzle or ejecting conduit or tube.

BRIEF DESCRIPTION OF THE INVENTION

The above can be achieved by means of apparatus for cutting fibre material according to claim 1, and by means of a control method according to claim 10.

In particular, according to the invention a method has been provided for cutting fibre material in which a strand fibre material is fed through a cutting device of rotary type, by which the fibre material is cut into tufts having a preset cutting length, and in which the single tufts of fibres are entrained by an air flow along an ejection conduit, comprising the steps of:

causing an acceleration of each tuft of fibres, immediately after cutting;

detecting the passage of each fibre tuft along the ejection conduit and generating a pulse control signal related to the real cutting frequency of the tufts, during a preset unit of time;

monitoring the flow of tufts along the ejection conduit, by comparing the detected real cutting frequency with a preset threshold value; and of

stopping operation of the cutting device when the cutting frequency decreases below the aforesaid threshold value.

According to another aspect of the present invention, an apparatus has been is provided for cutting fibre material and for monitoring the tufts of cut fibres, in which a strand of fibre material is fed through a backing and a cutting roller of a rotary cutting device, in which the cutting roller is provided with a plurality of angularly spaced cutting blades, and in which the tufts of cut fibres are conveyed by an air flow along an ejection conduit, comprising:

air jet generating means for acceleration of the tufts of cut fibres which travel along the ejection conduit;

an optical tuft detecting device for detecting the flow of tufts flowing along the ejection conduit;

a control signal generator, operatively connected to the optical tuft detecting device to generate a pulse

control signal related to the real fibre cutting frequency of the rotary cutting device; and

a frequency control unit having an inlet fed with the pulse control signal, from the control signal generator, said control unit being constructed and designed to stop the cutting apparatus when the real cutting frequency provided by said signal generator is below a threshold value preset in said control unit.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects and features of the invention will be made clearer by the following description with reference to the accompanying drawings, in which:

Fig. 1 is a general diagram of the apparatus according to the invention;

Fig. 2 is a first graph to illustrate the operating features of the apparatus of Figure 1;

Fig. 3 is a second graph to illustrate the operating features of the apparatus of Figure 1;

Fig. 4 is a view of a preferred embodiment of the cutting apparatus according to the invention;

Fig. 5 is a cross sectional view along line 5-5 of Figure 4;

Fig. 6 is a perspective view of the cutting unit with movable blades, forming part of the apparatus of Figure 4;

Fig. 7 is a longitudinal sectional view along line 7-7 of Figure 6;

Fig. 8 is an enlarged cross sectional view along line 8-8 of Figure 7.

DETAILED DESCRIPTION OF THE INVENTION

With reference to Figures 1 to 3, we will describe the

general features of the invention; as shown by the illustrative diagram of Figure 1, the apparatus comprises a cutting device 10 of the rotary type, for cutting into tufts 14 a strand or a continuous roving of fibres 11 which is fed into the nip between a cutting roller 12 and a backing roller 13 to produce in continuation tufts 14 of cut fibres, having a preset length, which are conveyed and entrained by means of a flow of air along a guide and ejection conduit 15 for deposition and/or distribution into a mould or onto an underlying substrate 16.

In a manner per se known, the cutting roller 12 is provided with a plurality of cutting blades 17, for example four as in the case shown, angularly spaced apart, which radially protrude from the cylindrical surface of the same roller and which longitudinally extend to the latter.

In turn the backing roller 13 which co-operates with the cutting roller 12 for cutting the fibre material 11 comprises an elastic surface covering 18, for example in rubber, which allows partial penetration of the cutting blades 17 at the grip point of the fibres material 11 between the two rollers 12 and 13.

The two rollers 12 and 13 of the cutting device are made to rotate simultaneously by means of a drive motor 19 of any suitable type, such as electric, hydraulic or air, connected to two rollers, for example by means of gears 20 and 21.

A theoretical cutting frequency for the fibre material 11, that is to say the theoretical number of tufts 11 which could be cut per unit of time, and which is substantially related to the cutting speed of the roller 12 and to the number of the cutting blades 17, may have a preset value,

that can be changed by increasing or decreasing the rotational speed of the rollers 12 and 13. The theoretical cutting frequency can also be controlled by means of a pulse signal generator 22 directly or indirectly connected to the drive motor 19, to generate a first reference pulse signal S1 having a frequency related to the theoretical cutting frequency of the same cutting device 10. The signal S1 is supplied to a first inlet I1 of an electronic control unit 23, comprising for example a computer or a PLC.

The apparatus of Figure 1 also comprises an optical control device 24, downstream the cutting device 10, at the ejection conduit 15, for monitoring the flow of cut fibres, that is to say the passage of the fibre tufts 14 through the ejection conduit 15, as schematically indicated, and consequently the working conditions of the cutting device 10.

The optical device 24, schematically indicated in Figure 1, comprises a pulse signal amplifier 25 for the optical signal emitted by a light emitting diode 26 connected to a first bundle of optical fibres 27 which penetrates the wall of the ejection conduit 15, and which is received by a light detecting diode 28, connected to a second bundle of optical fibres 29 which penetrates the wall of the ejection conduit 15 in a position diametrically opposite the first bundle of fibres 27.

The output of the amplifier 25, in the form of a second pulse signal S2, is sent to a second inlet I2 of the electronic control unit 23 to be compared with pulse signal S1. As an alternative to the control unit 23, the output of the amplifier 25 can be sent to the inlet I3 of a control board 30 provided for example by an LM2917N frequency-voltage converter of National, to actuate a controlled

switch or relay 31 in a circuit 32 for powering the drive motor 19 for the cutting device 10, or connected to an alarm circuit 33, designed to operate when S2 drops below a preset threshold value which, if required, can be made adjustable by manually acting on a trimmer of the control board.

The operation of the apparatus, both in the case of use of the control board 30 fed with the pulse signal S2 from the amplifier 25, and in the more complex case of use of an electronic control unit 23, by means of which it is possible to make a comparison between the reference signal S1 indicative of the theoretical cutting frequency, and the signal S2 indicative of the real cutting frequency, will be described hereinbelow, taking account of the following:

A) theoretical cutting frequency: refers to the number of cuts which can in theory be made in a preset unit of time, equal to the product of the rotational speed of the cutting roller 12, expressed as number of revolutions per second, by the number of cutting blades 17, which is proportional to the pulse number of the signal S1 emitted by the signal generator 22, during the same unit of time;

B) real cutting frequency: refers to the number of pulses of the control signal S2 emitted by the optical device 24 during the preset period of time, corresponding to the number of tufts 14 actually cut and detected during said unit of time.

First case

In the case wherein the cutting device 10 is controlled by means of the board 30 and operates perfectly, the number of cuts and hence the number of tufts 14 actually cut in the unit of time should correspond to the theoretical frequency

or theoretical number of cuts which can be made with the cutting device 10. This condition is represented symbolically by the correspondence between the signals S1 and S2 of the graph in Figure 3 during each period of time T1, T2. In practice, due to the wear of one or more blades, or due to breakage of the same, or for other causes, the number of cuts actually made and detected may be less than the theoretical or planned one. In this case the real cutting frequency of the control signal S2 emitted by the amplifier 25, always understood as the number of cuts made and detected in the unit of time, is less than the theoretical cutting frequency of the signal S1. This condition is represented by the signal S2' of the graph in Figure 3, always in the periods of time T1 and T2, in the case of breakage of one of the four cutting blades 17. In the case of Figure 3 it has been assumed that the cutting roller 12 performs four cuts per rev in the period of time T, and that the intervals between light and darkening of the optical detector are the same. In practice these intervals will be different, according to the speed of rotation of the roller 12, the cutting length for the tufts, and the acceleration supplied by an air flow.

If it is supposed that a user considers a reduction in the number of cuts to be acceptable, establishing for example a threshold A1 of 80%, as shown in figure 2, below which it is not admissible to drop, should the real cutting frequency falls below the threshold A1, in this case the apparatus must intervene to supply an alarm signal, or to interrupt operation of the cutting device. Therefore, until the frequency of the control signal S2 is equal to or higher than the threshold A1, the apparatus will continue to operate normally. Having reached the threshold A1 and the frequency of the signal S2 falling further, the control board 30 will intervene to actuate the relay or switch 31,

triggering the alarm 33, and/or will interrupt the circuit 32 for powering the electric motor 19.

Having an operator eliminated the causes of default, the apparatus may restart regular operation.

As referred previously the individual tufts of fibre 14 cross in flight the optical barrier of the two bundles of optical fibres 27 and 29, and repeatedly interrupt the ray of light so that the circuit 25 emits a pulse signal S2 in the form of a square wave signal, whose high and low statuses, corresponding to the instants of light and darkness, are indicative of the number of cuts performed. In other words, the frequency of the signal S2 (number of alternations of high signal and low signal, or of light/dark in a preset unit of time) indicates the passage frequency of the tufts of cut fibres 14 through the ejection conduit 15, i.e. the number of cuts actually performed.

A check on this frequency, compared with the set threshold value, allows the efficiency of the cutting device to be evaluated and any clogging of the ejection conduit 15 by the tufts of cut fibres 14 to be checked. In fact, in the event of obstruction, the passage of light between the two bundles of optical fibres 27 and 29 would be interrupted, supplying at the output of the circuit 25 of the optical detection device 24 a flat or zero signal, which is interpreted by the control board 30 as an emergency situation, so as to interrupt instantaneously the operation of the cutting device 10.

Second case

As referred previously, the second solution involves the

use of the electronic control unit 23, comprising a computer or PLC, in substitution of the control board 30.

This second solution, more complex than the previous one, allows complete control of the working conditions of the cutting apparatus and constant monitoring of the flow of the tufts of cut fibres 14 through the ejection conduit 15.

As shown in Figure 1, the signal S1 from the signal generator 22, which is operatively connected to the roller 12 of the cutting device 10, is sent to an inlet I1 of the electronic control unit 23. Simultaneously the signal S2 from the amplifier 25 of the optical signal for detecting the passage of the fibre tufts 14, is sent to a second inlet I2 of the electronic control unit 23. This latter is also programmed with data relating to the number of blades 17 of the cutting device 10 so that, as a function of the signal S1, related to the rotational speed of the roller 12, it can calculate in real time the theoretical cutting frequency for the bundle of fibres 11.

The electronic control unit 23 which governs the entire system, is also programmed to carry out a comparison between the signals S1 and S2 received at its inlets I1, I2 in a digital form, which are continuously counted so as to know, always in real time, as a result of the comparison, both the working conditions of the cutting device 10, and monitoring of the flow of cut fibres 14 through the ejection conduit 15.

The logic which governs the control system may be of any required type, for example the setting of two trigger thresholds A1 and A2 as indicated in the graph of Figure 2; more specifically:

i) Control of the working conditions of the cutting device 10: having established that a difference, for example of 20%, of the real cutting frequency given by the control signal S2, as indicated by the threshold A1 in the graph of Figure 2, in relation to the theoretical cutting frequency obtained from the signal S1, is acceptable, while this difference is equal to or above the threshold A1 this will indicate that the cutting device 10 working regularly, and that the number of cuts obtained in the unit of time, even if below the theoretical, is in any case acceptable.

Contrarily, in the case wherein the difference between the two cutting frequencies drops below the threshold A1 which defines the range of acceptability, it will mean that one or more cutting blades 17 are worn, or broken, and that the working conditions of the cutting device are no longer acceptable.

In this case the control unit 23 which governs the system may be programmed so as to stop the production cycle or simply to emit an alarm signal at the end of the production cycle underway. Having completed this cycle, the apparatus will automatically be stopped, allowing an operator to intervene to replace the worn or broken blades.

ii) Clogging of the ejection conduit 16: in this case it is possible to define a second trigger threshold A2, equal for example to 10% of the theoretical cutting frequency, see Figure 2, on reaching of which there is a drop to very low values of the difference between the frequency of the control signal S2 and S1, which indicates that there is clogging of the ejection conduit 15 which prevents the cut tufts 14 from flowing out. In this case the electronic control unit 23 may be programmed to stop the production cycle underway immediately so as to avoid serious damage to

the cutting device 10.

The system described is useful in practice for any application, for example for the preparation of reinforcement preforms for moulded products in thermosetting plastic material, or for the production of thermoplastic materials reinforced with glass fibres or of another type of fibre, such as polyurethane materials reinforced with glass fibres which are introduced into the liquid mixture directly at the time of its feeding, for example as explained hereinbelow with reference to Figure 9 in the European patent application EP 0 895 815 published on 10 February 1999, in the name of the same applicant, whose content integrates the present description.

As referred previously, the tufts of fibres 14 are entrained along the ejection conduit 15 by means of an air flow.

According to another aspect of the invention, the working operation of the cutting device 10 and of the optical device 24 for detecting and monitoring the tufts of fibres 14 can be considerably improved, or made more efficient, if each tuft of fibres 14, immediately after cutting, is strongly accelerated, with an entrainement speed by the flow of transport air which is higher, for example double or in general higher than the feeding speed of the bundle of fibres 11 through the rollers 12, 13 of the cutting device 10.

This can be obtained, for example, by feeding a pressurised jet of air by means of an injection conduit 34, which opens near or at a narrow section of the ejection conduit 15 defining a "Venturi", at the end of the same conduit 15 facing the cutting device 10. The conduit 34 is connected

to an appropriate pressurised air source, not shown, via a control valve 35 which allows the rate of air flow fed to be changed, in order to seek the best working conditions according to the features and type of fibres to be cut, and in relation to the cutting length of the fibre tufts 14.

The effect of the air jet injected by the conduit 34, directly into the fibre ejection conduit 15, downstream of the cutting device 10, between the latter and the optical detecting device 24 for monitoring the tufts of cut fibres, in addition to accelerating the speed of the tufts 14 through the optical barrier of the device 24, making the reading of the signal S2 more reliable, also allows the fibres to be pre-orientated and maintained perfectly taut in the flow direction or of the axis of the ejection conduit 15, even before cutting, for the space between the conduit 15 and the gripping point of the two rollers 12 and 13 of the cutting device 10.

As referred previously, the apparatus is capable of operating appropriately when the space between a tuft 14 and the subsequent one, at the time of cutting, reaches a sufficient value for allowing the required degree of discrimination by the optical detection device. By way of an example, in the case of a relatively short cutting length, of the order of a few centimetres or smaller, the space between the tufts 14 can be equal to or greater than the same cutting length. It is however important for this spacing to be reached rapidly within a length of a few millimetres, after cutting. It is therefore of a certain importance to define the position of the injection point for the jet of air fed by the conduit 34, both in relation to the gripping point between the rollers 12 and 13, and in relation to the narrow section of the Venturi defined by the upper end of the ejection conduit 15, having the

possibility of adjusting the flow rate of the air jet by means of the control valve 35.

In this respect good results have been obtained by injecting the air into the ejection conduit 15, near the narrow section of the Venturi, between the cutting device 10 and the optical detection device 24, maintaining a space from the gripping point the rollers 12 and 13 substantially equal to or slightly shorter than the minimum cutting length of the fibres. In fact the air injected into the ejection conduit 15 accelerates the newly cut off tuft 14, moving it swiftly away from the cutting device 10 at a speed higher by at least one third than the feeding speed for the fibre material 11. For example the feeding speed of the fibres 11 can be between 1 and 10 m/s, while the speed of the tuft 14, drawn by the stream of air, can be between 15 and 25 m/s. This speed is reached in a very short space of few mm which separates the cutting device 10 from the injection point for the air, and from the optical detection device 24. In this way a high degree of discrimination of the individual tufts of fibres and improved working efficiency of the entire device are achieved. In fact the air jet injected in the conduit 15, near the narrow section of the Venturi, on the inlet side for the tufts 14, in addition to the acceleration of the tufts 14 which move towards and through the optical detection or counting device, causes an additional effect of suction which acts on the fibres of a subsequent tuft, before cutting, maintaining them straightened and aligned with the axis of the ejection conduit.

With reference to the remaining Figures 4 to 8, we will now describe a particular embodiment of the rotary cutting device, with movable blades, i.e. capable of providing different cutting lengths which can be appropriately

controlled and monitored by means of the apparatus described previously. In this case the electronic control unit 23 must be programmed with different control data relating to the different cutting sizes and/or rotational speeds of the rollers 12 and 13.

As shown in said figures, the cutting device 10 comprises a body 36, formed in several parts, for supporting a cutting roller 12 provided with a plurality of cutting blades 17A, 17B, and a backing roller 13 provided with a rubber covering 18, as described previously.

Reference 19 in Figure 5 once again denotes the drive motor directly connected to the backing roller 13 and indirectly to the cutting roller 12 by means of gears 20 and 21.

Unlike conventional cutting devices, with fixed blades, the cutting device according to the present invention is of the type with movable blades, wherein some of the blades or all the blades can be radially moved between an advanced condition, wherein the movable blades project radially from the peripheral surface of the roller 12, against the roller 13, and a retracted position wherein the movable blades are away from the backing roller 13.

The forward and backward movement of the cutting blades can be performed by any suitable means; for example a preferred embodiment is represented in Figures 6 to 8 of the accompanying drawings. In the case of Figures 6-8 a cutting device with twelve blades has been shown, comprising six fixed blades 17B and six movable blades 17A, alternately disposed with the previous ones, which are movable both in a radial and in an axial direction as described hereinbelow.

In particular the cutting roller 12 comprises a grooved drum provided with twelve grooves 37 in radial planes, which extend longitudinally along the entire axial length of the drum itself.

Each cutting blade 17A and 17B is supported in an interchangeable manner by a blade holder 38A, 38B having a wedging shape, i.e. having a bottom surface 39 slanted in relation to the longitudinal axis of the roller, which adapts to a correspondingly slanted surface 40 at the bottom of each groove 37.

The slanting of the surfaces 39, 40, in relation to the longitudinal axis of the roller 12, depends on the stroke necessary for projecting or withdrawing the movable cutting blades 17A completely in relation to the peripheral surface of the grooved roller. By way of an example the slanting of the surfaces 39, 40 can be between 5° and 15°.

The fixed blades 17B with the respective blade holder 38B are restrained axially in the respective grooves 37 so as to project from the peripheral surface of the roller 12, blocking the blade holder by means of a screw 41 (Figure 6) screwed into a threaded hole at the front end of the same roller.

Contrarily the movable blades 17A are supported by blade holders 38A capable of sliding longitudinally in the respective guide grooves 37. Unlike the fixed blade holders 38B, the movable blade holders 38A have a widened base sliding in a corresponding guide part of the groove 37.

The sliding of each movable blade holder 38A, between a forward position shown in Figures 6 and 7, wherein the mobile blades 17A are totally retracted in relation to the

peripheral surface of the roller 12, and a backward position wherein the blades 17B project from the peripheral surface of the roller 12 due to the slanting surfaces 39 and 40, can be obtained for example by rotatingly connecting the movable blade holders 38A to the stem 43 of a piston 44 of a pneumatic cylinder 45.

More specifically, in the example shown of Figure 7, each movable blade holder 38A has a projection 46 radially directed towards the axis of the roller 12, which engages between a front flange 47 and a rear flange 48 of two bushes 49 and 50, screwed to each other and connected to the stem 43 of the hydraulic drive cylinder 45 by means of rotating bearings 51 in order to define a rotating joint. Therefore the forward and backward movement of the blade holders 38A, driven by the cylinder 45, causes the forward and backward movements of the movable blades 17A. In this way it is possible to control the cutting length of the tufts of fibres according to the specific working needs, under the control of the electronic unit 23 which manage the entire working process of the cutting apparatus.

CLAIMS

1. Method for cutting fibre material, in which a strand (11) of fibre material is fed through cutting rollers (12, 13) of a cutting device (10), by means of which the fibre material (11) is cut into tufts (14) having a preset cutting length, and in which the individual tufts (14) are entrained by an air flow along an ejection conduit (15), characterised by the steps of:

causing an acceleration of each tuft (14) immediately after cutting;

detecting the passage of each tuft (14) along the ejection conduit (15), and generating a pulse control signal (S2), related to the real cutting frequency of the tufts (14) during a preset unit of time;

monitoring of the tufts (14) which are flowing along the ejection conduit (15), by comparing the real cutting frequency (S2) of the tufts (14) with a preset threshold value; and

stopping the working of the cutting device (10) when the real cutting frequency (S2) is lower than the aforesaid threshold value.

2. Method according to claim 1, characterised by:

generating a first pulse control signal (S1), related to a theoretical cutting frequency of the fibres (11), during a preset unit of time;

generating a second pulse signal (S2) related to the real cutting frequences of the fibres (11), and to provide cut tufts (14);

accelerating of each tuft of fibres (14) by a jet of flow air (34), after cutting;

monitoring the working conditions of the cutting device (10) and the flow of tufts (14) by comparing the second pulse signal (S2) with the first control signal (S1)

related to the theoretical cutting frequency; and

stopping the cutting device (10) when the difference between the theoretical frequency and the real cutting frequency provided by said first (S1) and second (S2) control signals, is below a preset threshold value.

3. Method according to claim 1, characterised in that each tuft (14) is accelerated, simultaneously maintaining in a taut condition the fibres (11), until the cutting, by the same air (34) injected into the ejection conduit (15).

4. Method according to claim 3, characterised in that the jet of air (34) for entraining the tufts (14) is injected in a position between the cutting device and the point (27, 29) for monitoring the flow of cut tufts (14).

5. Method according to claim 4, characterised in that the air jet (34) is injected near a narrow section of the ejection conduit (15).

6. Method according to claim 4, in which the cutting device (10) comprises a pair of rollers (12, 13) for gripping and driving the fibre material (11) to be cut, characterised in that the air jet (34) is injected at a space from the gripping point for the fibres (11) equal at least to the length of cut tufts (14).

7. Method according to claim 1 or 2, characterised in that each tuft (14) is accelerated immediately after cutting, at a speed at least one third higher than the feeding speed for the fibre material (11) to be cut.

8. Method according to claim 2, in which the cutting device (10) comprises a pair of cutting rollers (12, 13), one of which (12) is provided with a plurality of cutting

blades (17), characterised by controlling the cutting conditions of the individual blades (17) by monitoring the flow of tufts (14) and stopping the cutting device (10) when the comparison between the theoretical (S1) and the real (S2) cutting frequency is below a first preset threshold value (A1).

9. Method according to claim 8, further characterised by detecting clogging of the ejection conduit (15) by monitoring the flow of cut tufts (14) and stopping the cutting device (10) when the comparison between the theoretical (S1) and the real (S2) cutting frequency is below a second threshold value (A2), lower than the first aforesaid threshold value (A1).

10. Apparatus for cutting fibre material and for monitoring the tufts (14) of cut fibres, according to which a strand (11) of fibre material is fed through rollers (12, 13) of a rotating cutting device (10), one of which (12) is provided with a plurality of angularly spaced cutting blades (17), and in which the tufts (14) are conveyed by means of air flow along an ejection conduit (15), characterised by comprising:

air jet generating means (34, 35) for accelerating the tufts (14) along the ejection conduit (15);

an optical tuft detecting device (25, 27, 29) for detecting the flow of tufts (14) flowing along the ejection conduit (15);

a control signal generator (24), operatively connected to the optical detecting device (25, 27, 29) for detection of the flow of tufts (14) and to generate a pulse signal (S2) indicative of a real cutting frequency; and

a control unit (23) having a signal inlet (I2) fed with the pulse signal (S2), said control unit (23) being constructed and designed to stop the cutting apparatus when

the pulse signal (S2) emitted by said signal generator (24) is below a preset threshold value (A1).

11. Apparatus according to claim 10, further characterised by comprising a further pulse signal generator (22) to provide a further pulse signal (S1) related to a theoretical cutting frequency of the tufts (14), and in that said control unit (23) is constructed and designed to stop the apparatus when the comparison between the pulse signals (S1, S2) related to the theoretical (S1) and the real (S2) cutting frequency is below a second threshold value (A2) lower than said preset threshold value (11).

12. Apparatus according to claim 10, characterised in that the optical detecting device (24) for the flow of cut tufts (14) comprises an optical sensing means (27, 29) in the ejection conduit (15), downstream of a narrow section of the same conduit (15) to accelerate said air jet (34).

13. Apparatus according to claims 10 and 12, characterised in that said air jet generating means are provided near the narrow section of the ejection conduit (15), between the cutting device (10) and the optical detection device (24, 27, 29) for the cut tufts (14).

14. Apparatus according to claim 10, characterised in that the cutting roller (12) of the fibre cutting device (10) comprises a plurality of cutting blades (17A) radially movable between an advanced position in which the cutting blades (17A) partially protrude from the peripheral surface of the cutting roller (12) and a retracted position in which the cutting blades (17A) are backward in relation to the peripheral surface of the same cutting roller (12) of the cutting device (10).

15. Apparatus according to claims 10 and 14, characterised in that the cutting roller (12) comprises a grooved drum having a plurality of longitudinally extending radial grooves (37) which open towards the peripheral surface and one end of the drum, each groove (37) comprising a bottom surface (40) slanting in relation to the longitudinal axis of the same drum; and in that each movable blade (17A) is carried by a slider (38A) radially and longitudinally movable in a respective guide groove (37) of the support drum, each movable blade holder (38A) having a slanted bottom surface (39) sliding in contact with the slanted bottom surface of the aforesaid guide groove (37).

16. Apparatus according to claim 15, characterised in that the movable sliders (38A) for supporting the movable blades (17A) are connected to a linear actuator (45), by rotating joint (51).

17. Apparatus according to claim 14, characterised by comprising a plurality of movable cutting blades (17A), each disposed between stationary cutting blades (17B).

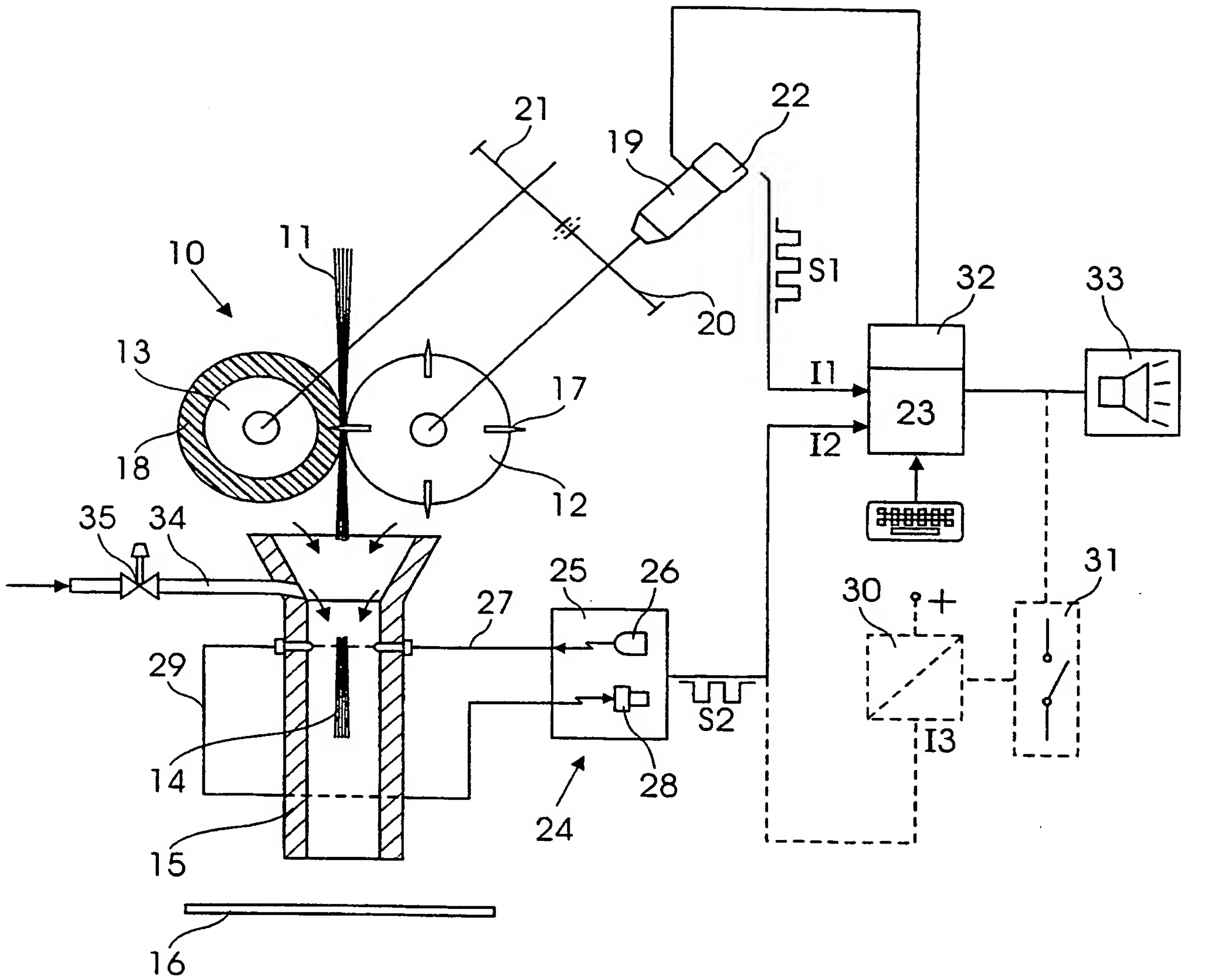
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Fig. 1

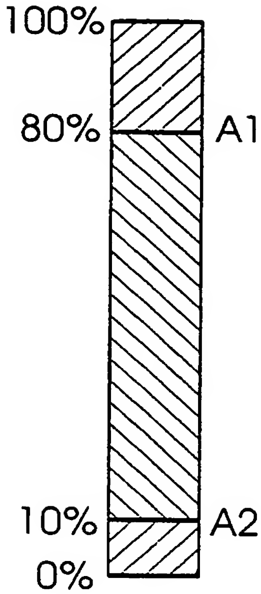


Fig. 2

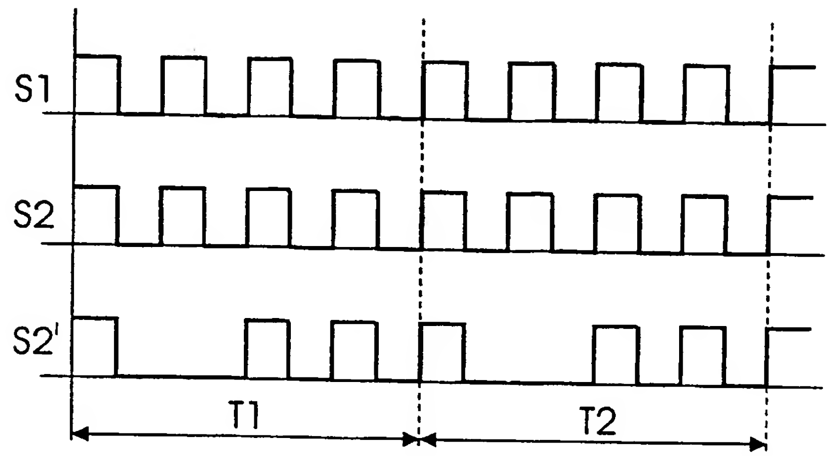


Fig. 3

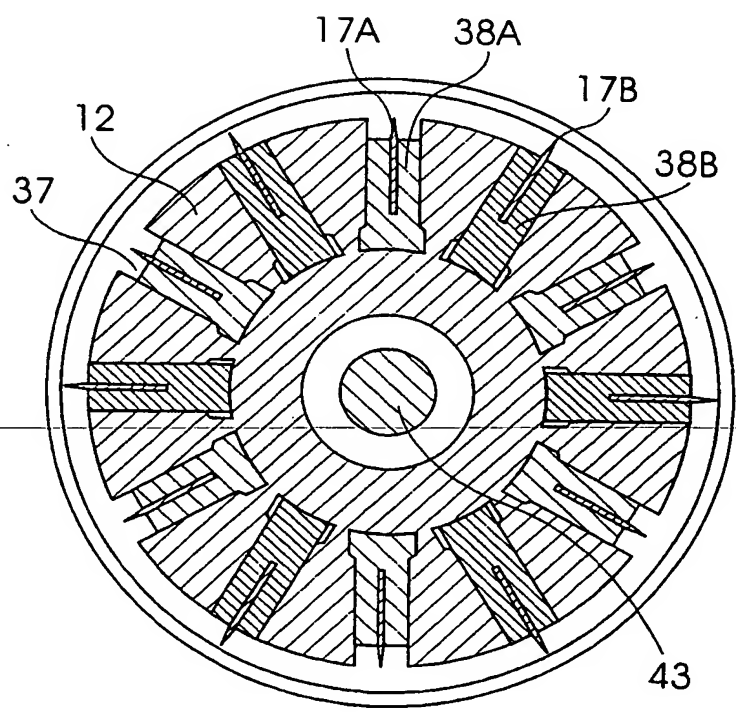


Fig. 8

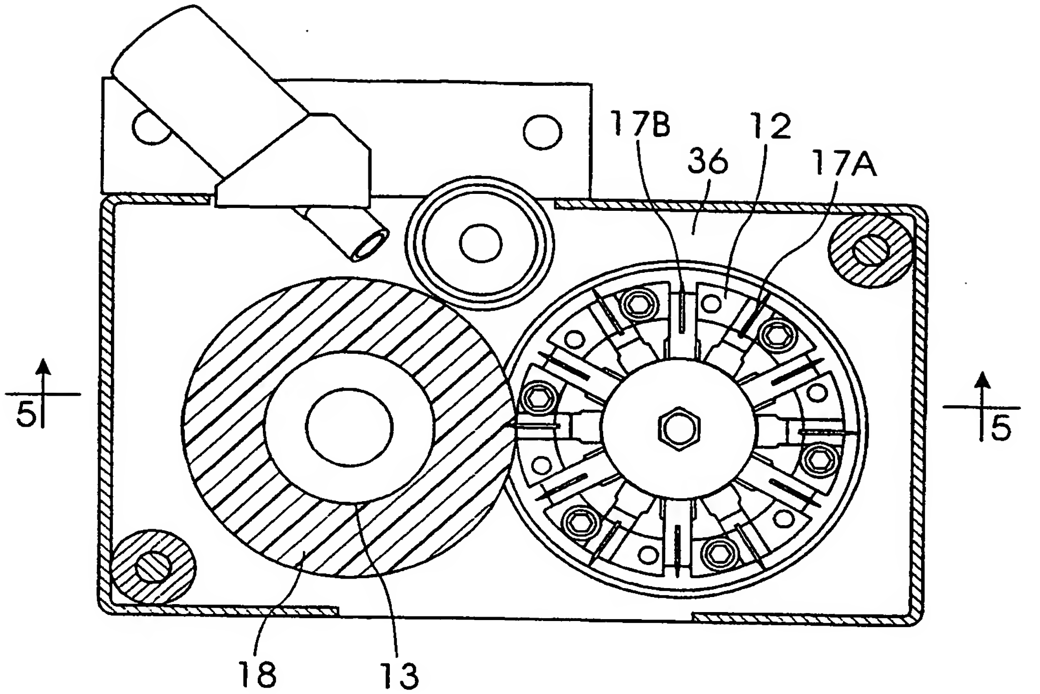


Fig. 4

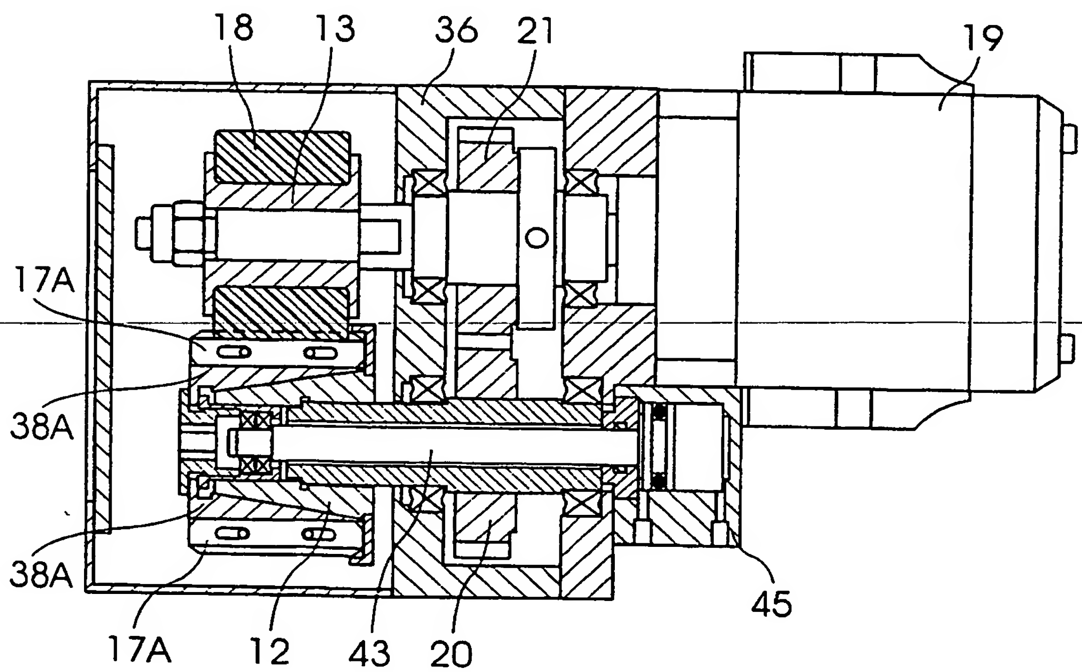
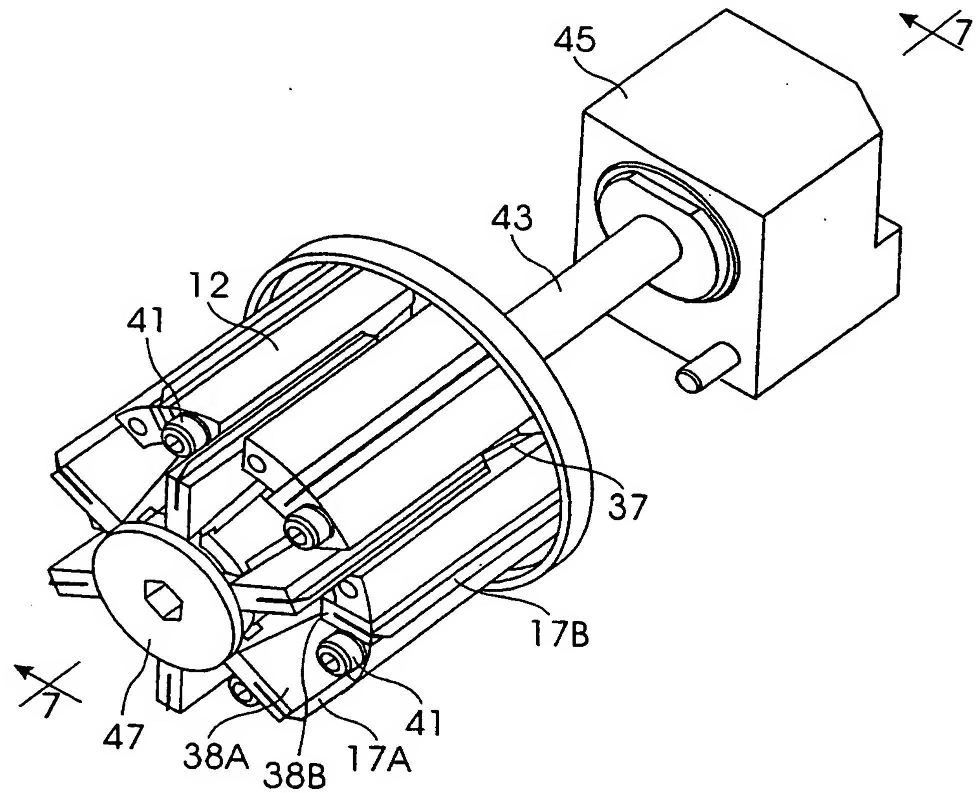


Fig. 5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17B
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38A
38B
17A
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Fig. 6

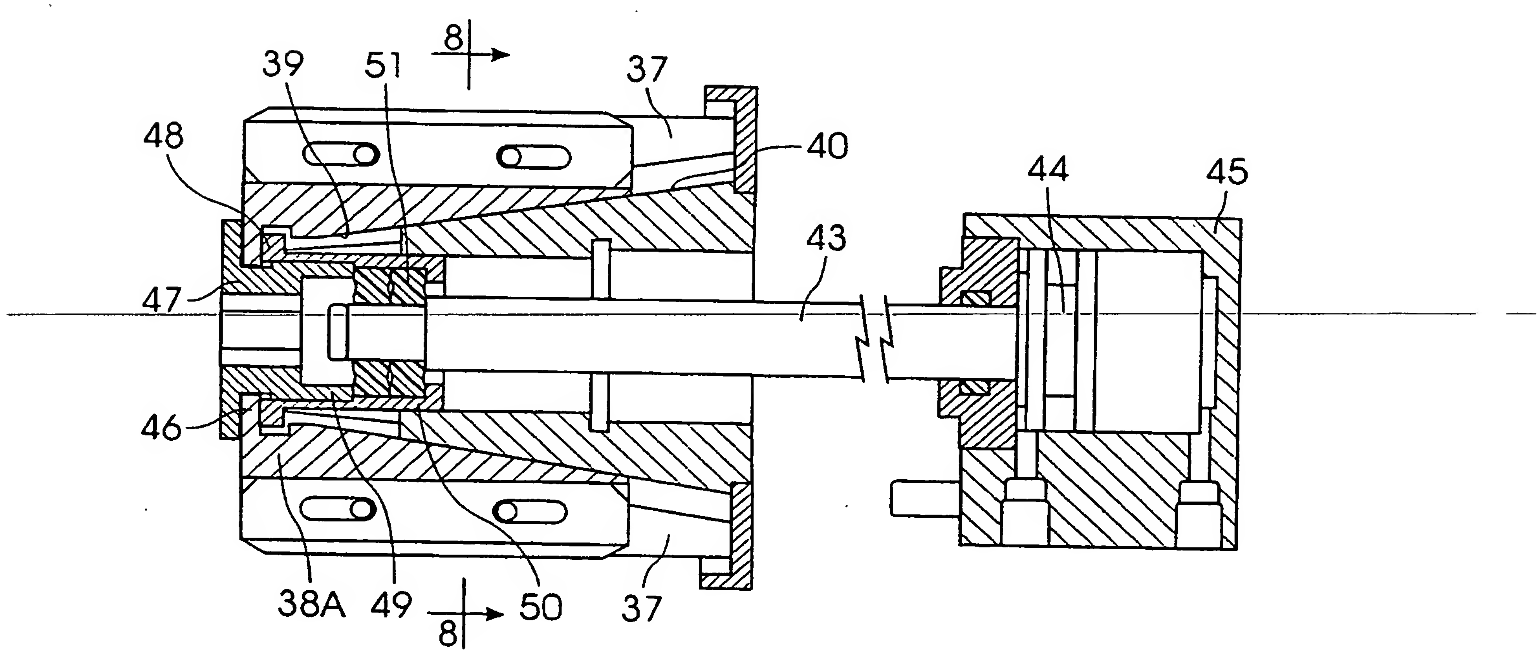
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Fig. 7

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 00/08855

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 D01G1/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 D01G C03B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	FR 2 441 670 A (PILKINGTON BROTHERS LTD) 13 June 1980 (1980-06-13) page 2, line 5 -page 5, line 24; claims 1,2,6,10,11; figures 1,2	1,4,5,8, 10,14
Y	WO 93 11288 A (NORDSON CORP.) 10 June 1993 (1993-06-10) page 6, paragraph 1 -page 12, paragraph 1 page 14, paragraph 2 -page 20, paragraph 1 page 31, paragraph 2 -page 42, paragraph 1; claims 1,2,6,10,11,30,36; figures 1-3,8,9	1,4,5,8, 10,14
A,P	EP 0 978 580 A (VETROTEX FRANCE S.A.) 9 February 2000 (2000-02-09) the whole document	1,13

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 December 2000	29/12/2000

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

Intern ıal Application No
PCT/EP 00/08855

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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